

III. "Note on the Number of Micro-organisms in Moorland Air." By Professor CARNELLEY, D.Sc., and THOS. WILSON, University College, Dundee. Communicated by Sir HENRY ROSCOE, F.R.S. Received February 3, 1888.

As no determinations appear to have been made of the number of micro-organisms in moorland air, the following results obtained last summer may be of interest as forming a small contribution to our knowledge of the distribution of micro-organisms in the air of different localities.

Our determinations were made "on the heather" in the neighbourhood of Midtown, in the parish of Tanadice, in Forfarshire. This forms a part of the Clova district, so well known to botanists as the habitat of many rare mountain and moorland plants. Midtown is situated at a height of about 1000 feet above the level of the sea, and is far removed from towns and other sources of contamination, as is evidenced by the fact that the nearest railway is about six miles away.

We also made simultaneous estimations of the carbonic acid by Pettenkofer's method. The process employed for the determination of the micro-organisms was the "flask method," which we have already described in a previous paper. The samples of air were taken at a height of about 3 feet from the ground. The results obtained are represented in the following table. 10 litres of air were aspirated in each case. More determinations would have been made, but owing to an accident the remainder of the flasks were unfortunately spoilt.

| No. | Date. | Time. | Weather. | Wind. | Temper- ature. | Carbonic acid vols. per 10,000. | Micro-organisms per 10 litres of air. | | |
|-----|----------|-------------|-----------------------------|-----------------|-------------------|------------------------------------|---|---------|--------|
| | | | | | | | Bacteria. | Moulds. | Total. |
| | 1887. | | | | | | | | |
| 1 | Aug. 3rd | 5 p.m. ... | Bright sunshine, no clouds | Moderate, S.E. | 63° F. | 4·2 | 0 | 8 | 8 |
| 2 | " 5th | 9.30 a.m. | Bright sunshine, cloudy | Strong, S. | 70 | 4·0 | 0 | 2 | 2 |
| 3 | " 8th | 9.20 a.m. | Cloudy | Gale, W. | 70 | 4·0 | 0 | 4 | 4 |
| 4 | " 9th | 2 p.m. ... | " | Strong, W. | 65 | 3·3 | 0 | 0 | 0 |
| 5 | " 15th | 10 a.m. ... | Bright sunshine, few clouds | Gentle, W. | 58 | 3·6 | 0 | 0 | 0 |
| 6 | " 19th | 9.30 a.m. | Cloudy | Moderate, N.W. | 58 | 4·3 | 0 | 7 | 7 |

The weather had been fine and dry for a long time previous to August 9th, but between that and the 15th there were several days of rain.

It will thus be seen that *not a single sample contained bacteria, and that all the micro-organisms obtained consisted of moulds, amounting on the average to 3·5 per litre.*

Now Miquel and Dr. P. Frankland have each shown that the air is much richer in micro-organisms during the summer than during the winter, there being a minimum about midwinter and a maximum about July and August, thus :—

| | Miquel. | | P. Frankland. |
|---------------------------------|-------------|--------|-------------------|
| | Montsouris. | Paris. | South Kensington. |
| Winter (Dec., Jan., Feb.) . . . | 2·0 | 21·3 | 12 |
| Spring (March, April, May) .. | 5·0 | 47·9 | 29 |
| Summer (June, July, Aug.) .. | 6·4 | 50·5 | 74 |
| Autumn (Sept., Oct., Nov.) .. | 4·8 | 37·0 | 30 |

It hence follows that the number of moulds we found in moorland air was probably a maximum, since the determinations were made in August, and that bacteria are absent all the year round in pure air from moors and hills away from towns.

In order to give an idea of the number of micro-organisms in moorland air as compared with air from other localities, the following table is appended, more especially as many of these data are not generally accessible to chemists :—

| Place. | Season of year. | Micro-organisms per 10 litres of air. | | | Authority. |
|---|----------------------|---------------------------------------|---------|--------|------------------------|
| | | Bacteria. | Moulds. | Total. | |
| Sea air (Atlantic Ocean) | — | 0 | 0 | 0 | Dennis. |
| High mountains | ? | .. | .. | .. | Miquel. |
| Moorland | .. | 0 | 3.5 | 3.5 | Carmelley and Wilson. |
| Country | Annual average | .. | .. | 4.6 | Miquel. |
| .. | Autumn | .. | .. | 6.8 | .. |
| " | August | .. | .. | 14.0 | P. Frankland. |
| Dundee, suburbs | Winter | 0 | 1 | 1.0 | Carmelley and Haldane. |
| " town, open places, night | " | 1.5 | 0 | 1.5 | " |
| " close places, " | " | 5.0 | 0.5 | 5.5 | " |
| " open places, day | " | 7 | 5 | 12 | " |
| " " " | Spring | 12.8 | 0 | 13 | " |
| Norwich, Cathedral Close | ? | .. | .. | 18 | Carmelley and Wilson. |
| Paris, Rue de Rivoli | Annual average | .. | .. | 39 | P. Frankland. |
| London, open places | August | .. | .. | 44 | Miquel. |
| " roof of Science Schools, South Kensington | ? | .. | .. | 24 | P. Frankland. |
| London, St. Paul's Churchyard | Annual average | .. | .. | 36 | " |
| Sewers (Paris) | August | .. | .. | 105 | " |
| (Bristol) | ? | .. | .. | 70 | " |
| (Westminster and Dundee) | Summer | .. | .. | 9 | Miquel. |
| Royal Infirmary, Dundee | Spring | 79 | 10 | 89* | Haldane. |
| Hospital for Consumption, Brompton | Winter | 42 | 17 | 59 | Carmelley and Haldane. |
| Hôpital de la Pitié, Paris | ? | .. | .. | 72 | " |
| Bed-rooms | Annual average | .. | .. | 96 | P. Frankland. |
| Three and more roomed houses, Dundee | Winter | 85 | 5 | 90 | Miquel. |
| Two | " | 434 | 26 | 460 | Carmelley and Haldane. |
| One | " | 585 | 15 | 600 | " |
| Naturally ventilated schools, Dundee | " | 160 | 6 | 166 | " |
| Mechanically " | " | 1510 | 10 | 1520 | " |
| Jute Mills, Dundee | " | 1140 | 46† | 1600 | " |

* Outside air at same time in streets above the sewers and at a height of 3 feet from the ground gave 130 at Bristol and 159 per 10 litres at Westminster and Dundee. The better a sewer is ventilated the larger is the number of micro-organisms present in the air of the sewer, since all, or by far the greater part of them, come from the outside air (compare Carmelley and Haldane, 'Roy. Soc. Proc.', vol. 42, p. 501).

N.B.—With the exception of those of Miquel, all the determinations given in the table were made with a solid cultivating medium, viz., Koch's gelatine-peptone.